Home and Community Care Core Manual: Negative Pressure Ventilation - PortaLung with the NEV-100

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This core section only includes basic information on the ventilator features that are relevant to the usual daily care of a child at home on a PortaLung NEV-100 negative pressure ventilator. It does not include all features found on the ventilator. Further information can be obtained from the manufacturers User Manual or by contacting the Clinical Technologists at RCH.

<table>
<thead>
<tr>
<th>Version</th>
<th>1</th>
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<tbody>
<tr>
<td>Date revised</td>
<td>Feb. 2010</td>
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<tr>
<td>Next revision date</td>
<td>August 2010</td>
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</table>
What is Mechanical Ventilation?

Mechanical Ventilation is the support of breathing for someone who can’t breathe at all, or can’t breathe well enough on their own. There are two ways that we can mechanically ventilate children, either through positive pressure (the most commonly used) or through negative pressure. With the PortaLung and NEV-100 we are using negative pressure ventilation.

What is Negative Pressure Ventilation?

Negative pressure ventilation mimics normal breathing. Humans like many animals breathe by negative pressure; the rib cage expands (opens up), the diaphragm (breathing muscle) pulls down which allows the chest cavity to open up. This causes the “pressure” in the chest cavity to decrease so air flows into the lungs to fill the space created by the opening up of the chest cavity. (see diagram below-normal breathing). The air will naturally flow into the lungs to equalise the pressure inside the chest to atmosphere (inside the chest has become negative in relation to the pressure in the outside atmosphere). When air is flowing into the chest, this is inhalation-the act of breathing in.

When a person is unable to either fully or partially control the muscles of breathing (the diaphragm and intercostal muscles), this normal process of breathing becomes difficult or impossible.

Negative pressure ventilation (i.e. the PortaLung) mimics normal breathing in that it creates a negative pressure inside the chamber. This negative pressure is transferred to the outside of the chest, which then transmits that pressure to the inside of the chest creating a “suction” effect (like a vacuum cleaner). The chest cavity responds to this negative pressure change by starting the process of inhalation. This suction effect draws the diaphragm down and expands (opens up) the chest cavity for breathing (just like the process of normal breathing). As the chest cavity opens up, the lungs expand.
allowing air to flow in through the nose and mouth. This is inhalation, the act of breathing in. When the child needs to breathe out, the pressure inside the chamber returns to atmosphere, allowing the chest muscles to relax and exhalation (breathing out) occurs.

1.2 PortaLung diagram:

![PortaLung diagram]

2 PORTALUNG WITH THE NEV-100

The PortaLung is a fibreglass cylinder which the child sleeps in with his head out the right end of the chamber through the spiral collar. Their head rests on a pillow on the platform. The negative pressure (flow of air) is created by the NEV-100 sucking air from the chamber through the tubing that connects to the two devices.

The PortaLung chamber consists of the following:

- Chamber made of molded fibreglass
- Quick opening door made of plexiglass
- Latching system with tight seals to hold door closed
- Mattress and pillow
- Spiral collar and headrest
2.1 What the carer needs to know about the PortaLung NEV-100

The carer will not be required to change any of the settings on the ventilator. This is only to be done by trained medical professionals or appropriately trained family members of the child and always in consultation with the child’s medical team.

The carer will need to know the parameters set on the NEV-100, how to ensure the PortaLung chamber is sealed properly, how to search for leaks, how to turn the NEV-100 on and off and use the STANDBY function. The carer will need to know how to put child into chamber, take him out and initiate and stop treatment. The carer must also be familiar with how to assess patient while in the chamber, and how to “troubleshoot” when alarms are set off. See “Troubleshooting” Guide. The carer will need to be familiar on how to adjust child’s position in chamber and loosen and tighten collar.

2.2 NEV-100 – Display Screen Settings

The Respironics NEV-100 is the Command and Control Centre for the PortaLung chamber. This is the screen that is displayed and will display the settings that have been set in advance.

Display Screen:

DIAGRAM: DISPLAY SCREEN NEV-100 {SHOWING MAIN MENU}:
3 Commonly Used Terms and Definitions related to NEV-100 Control Panel

3.1.1 Inhalation or Inspiration
Describes the act of breathing in or taking a breath.

3.1.2 Exhalation or Expiration
Describes the act of breathing out.

3.1.3 Breath Rate (bpm) or Respiratory rate
Number of breaths delivered by ventilator per minute; this will depend on the mode set. It may be the minimum number of breaths delivered to the patient or the total number of breaths.

3.1.4 Control
This mode controls all breaths given to the patient: the rate, the pressure and the time between inspiration (breaths in) and expiration (breaths out). All patient breaths are delivered at a set respiratory rate, set pressure and set inspiration time or I: E ratio.

3.1.5 Assist/Control
This mode functions the same as the Control mode, but in this mode the patient is able to initiate additional breaths that are extra or above the machine set rate.

3.1.6 Assist/Control + Sigh
This mode permits the child to initiate breaths (as described above) and to receive Sigh breaths (an extra large breath) delivered at pressures and frequency set in the ventilator.

3.1.7 Base Pressure
This is the peak pressure of the ventilator during the expiration (breathing out) phase. This pressure may be positive, negative or 0 cm of H2O. Pressures are measured by centimetres of water (cm H2O).

3.1.8 Continuous Negative Extra thoracic Pressure (CNEP)
This mode permits the user to adjust a continuous negative baseline pressure from -5 cm to -30 cm H2O.

3.1.9 Control + Sigh
Control mode (all breaths controlled by ventilator) with Sigh delivered at pressure and rate set by user. A Sigh is an extra large breath.

3.1.10 I:E Ratio
Ratio of Inspiratory Time (time it takes to take a breath in) to Expiratory time (time it takes to breath out).
3.1.11 Insp. Time
This refers to the amount of time (in seconds) that the ventilator allocated for inspiration. The set negative pressure will be applied for this period of time. For example, if the inspiration time is set at 1.0 seconds and the negative pressure is set to -25cm H2O, the ventilator will deliver -25cm H2O to the chest for 1 second. Often this time is abbreviated as “Ti” and can be set from 0.5 to 5.0 seconds.

3.1.12 Low Pressure Alarm (LPA)
The Low Pressure alarm is the only alarm that must be set. The LPA will alarm both in sound and by flashing on screen if the negative pressure value (i.e. -35 in panel screen) is not reached within 20 seconds of time set. The LPA in control screen is set (example above) at -30cmH2O

3.1.13 Mode
The mode the NEV-100 is set to. It has five different modes of ventilation it can operate in: Control, Control + Sigh, Assist/Control + Sigh and CNEP (see individual descriptions)

3.1.14 NEV-100
NEV stands for Non-invasive Extra thoracic Ventilation. This type of ventilation is used on children who can breathe on their own when awake and alert, but may not breathe adequately or at all when asleep or unconscious. The NEV-100 applies pressure on the outside of the body (extra thoracic) versus applying pressure directly into the lungs

3.1.15 Negative pressure
The peak pressure at which the child is ventilated (Inspiration). This is the maximum pressure that is exerted on the chest wall to enable the process of inhalation (breath in). The negative pressure set on control screen (above) is -35 cm H2O

3.1.16 Remote Alarm
This is an alarm which can be used remotely; it alerts the carer of an alarm condition at a distance of up to 300 feet from the ventilator. A tone sounds and a red light flashes to alert that an alarm has gone off

3.1.17 Sigh
An extra large breath

3.1.18 Sigh pressure
This is the pressure that the “Sigh” breath is delivered at. This pressure is usually set at a number between the set Negative pressure and -100 cm H2O. In control panel example above, the sigh pressure is set at -50cm H2O.
3.1.19 Multiples - Sigh multiples can be set as 1, 2 or 3 sigh breaths in a row
Frequency - the frequency of sigh breaths adjustable from 1-20 times/hour

3.1.20 Standby
Standby when selected “ON” stops the NEV-100 from cycling, but maintains power to the control panel and display screen. This is useful when initially setting up the NEV-100 or when you want to pause the ventilator for a short interval of time. STANDBY is most often used when the child wakes and needs to come out of the chamber for a short period of time or quick adjustments need to be made. The NEV-100 returns to normal operation (Standby OFF) three minutes after the panel becomes locked.

4 PortaLung Operating Instructions

PORTALUNG WITH THE NEV-100

Caution: While the door is in the open position, do not bump either chamber or door restraint which can force door to close suddenly causing injury to child or carer.

1. Gauge screwed onto gauge fitting on top of chamber. **Do not over tighten**
2. Loosen all screws onto the spiral collar, and gripping rod on inner ring, twist counter clockwise to OPEN, clockwise to TIGHTEN
3. Position child on mattress and slide child’s head so that the head goes through the vinyl hole. A small towel can be uses to protect the neck when sliding through. **Do not over tighten (the collar should be tight enough to seal but not tight enough to leave marks).** Hand tighten screws to prevent ring and collar from becoming loose
4. Close door and secure latches (latches secured usually only with younger patients-some patients these are left open).
5. Attach flex hose to the fitting on the chamber and to the ventilator NEV-100 (if not already fitted). Check that fittings are secure
6. Check that the Panel is on LOCK mode, only to be Unlocked if Parameters are to be changed by parents or Medical staff or to put on STANDBY mode.
7. **Check that breath rate and pressure levels are set according to medical orders given for child**
8. Probe ports:
• Select the hole needed to fit the probe (oxygen saturation probe)
• Insert probe through hole and connect to child
• Open slot of rubber stopper and lay line inside hole
• Re-insert rubber stopper into hole to obtain tight seal.

9. The portholes on the side of the PortaLung may be used while the ventilator is in use to access the child. Wait until the pressure inside the chamber has decreased before opening the port holes. Put each arm in one at a time through the foam sleeve of the port hole and ensure there is a good seal to prevent leaks. Allow pressure in chamber to equalise before entering second arm, or an alarm may be triggered. Attend to the child’s needs and then exit one arm at a time, close porthole before removing second arm allowing pressure in chamber to equalise. Close second port hole after arm is out of hole.

5 Troubleshooting Common Alarms

The NEV-100 has alarms that are set to alert the carer that there is a problem. When an alarm goes off you must always check the child before you take any further action, including silencing the alarm.

When an alarm goes off: the alarm bar flashes red. The alarm bar is located on the top of the NEV-100. The Alarm bar will display message, i.e. “Low Pressure Alarm”. Pressing the alarm silence key silences the sound, but the flashing will continue until alarm condition has been resolved.

1. Assist connector: connect a nasal cannula if patient initiated breaths are desired.
2. Patient hose port: connect straight end of patient hose into the patient hose port.
3. Pressure connector: connect the 1/8”I.D tubing from the patient hose connects to the pressure connector to monitor the pressure of the system

4. Power Switch: LED power switch turns power to NEV-100 On/Off.
5. AC Indicator: the AC indicator is lit when AC power is connected.
6. Alarm Silence key
7. Alarm Bar: flashes red

In the table below are some of the reasons the machine may alarm and what you should do (after checking the child) to fix the cause of the alarm. A complete list of alarms is contained in the PortaLung manual.

<table>
<thead>
<tr>
<th>Alarm</th>
<th>What it might mean</th>
<th>What to do</th>
</tr>
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<tbody>
<tr>
<td></td>
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<tr>
<td>message</td>
<td>1. Hose disconnection</td>
<td>Check hose connections</td>
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<tr>
<td>------------------</td>
<td>-----------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Low Pressure</td>
<td>2. Cracks or holes in hoses</td>
<td>replace hose if cracks or holes in hose</td>
</tr>
<tr>
<td>Alarm</td>
<td>3. Leaks along tubing, collar, portholes, seals around door</td>
<td>Reset door or replace seals</td>
</tr>
<tr>
<td>-alarm bar</td>
<td>4. PortaLung chamber:</td>
<td>Adjust collar (tighten it if loose), tighten seals, check latches are connected</td>
</tr>
<tr>
<td>flashes RED</td>
<td>-door improperly sealed, cracks in plastic</td>
<td>Check to see if child has created leak with arm out of collar</td>
</tr>
<tr>
<td>and sounding</td>
<td>5. Collar loose ;gap in collar</td>
<td>Contact parents if above has not fixed alarm condition</td>
</tr>
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<td></td>
<td>6. Alarm set too close to normal Negative pressure</td>
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</table>

<table>
<thead>
<tr>
<th>message</th>
<th>1. Failed diagnostic test</th>
<th>Do not put child into chamber until unit fully operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Operation</td>
<td>2. Internal failure</td>
<td>Check Child</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open Chamber and wake child up</td>
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<td></td>
<td></td>
<td>Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPAP)</td>
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<tr>
<td></td>
<td></td>
<td>Contact parents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn Unit off and press Alarm Silence Key</td>
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<tr>
<td></td>
<td></td>
<td>Notify RCH Clinical Technologists</td>
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<tr>
<td></td>
<td></td>
<td>Apply Alternative Ventilation (i.e., BiPap).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>message</th>
<th>1. Power cord improperly connected</th>
<th>Do not put child into unit until fully operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Operation</td>
<td>2. No power to electrical outlet</td>
<td>Check Child</td>
</tr>
<tr>
<td></td>
<td>3. Fuse on rear of NEV-100 is blown.</td>
<td>Open Chamber and wake child up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPap)</td>
</tr>
</tbody>
</table>

**Low Pressure Alarm**
- Alarm bar flashes RED and sounding
- Message reads: “Low pressure Alarm-check for leaks or disconnects.”

**No Operation**
- Power visual indicator does not light.
- Alarm bar is flashing; alarm is sounding.
- Message may read: “INTERNAL FAILURE, DO NOT USE, CALL FOR SERVICE”

**No Operation**
- Turned on, but not operating
- LCD is dark
- Alarm may be sounding or not sounding

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<table>
<thead>
<tr>
<th>Continuous Audible Alarm</th>
<th>Power Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm is sounding</td>
<td>Continuous audible alarm</td>
</tr>
<tr>
<td>LCD screen is lit</td>
<td>LCD screen is dark</td>
</tr>
<tr>
<td>Alarm bar is off; no alarm message</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Loss of power source</td>
</tr>
<tr>
<td></td>
<td>2. Power cord is improperly connected</td>
</tr>
<tr>
<td></td>
<td>3. NEV-100 fuses are blown</td>
</tr>
<tr>
<td></td>
<td>4. NEV-100 has been turned off</td>
</tr>
<tr>
<td></td>
<td>Check Child</td>
</tr>
<tr>
<td></td>
<td>Open Chamber and wake child up</td>
</tr>
<tr>
<td></td>
<td>Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPap)</td>
</tr>
<tr>
<td></td>
<td>Contact parents</td>
</tr>
<tr>
<td></td>
<td>Ensure Power is back on</td>
</tr>
<tr>
<td></td>
<td>Check NEV-100 settings</td>
</tr>
<tr>
<td></td>
<td>Press Alarm Silence Key.</td>
</tr>
</tbody>
</table>

Contact parents
Check power cord and connections
Check that household circuit breaker is closed or fuse is good, and electricity is supplied to the outlet
Check fuses on back of panel

Check Child
Open Chamber and wake child up
Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPap)
Contact parents
Ensure Power is back on
Check NEV-100 settings
Press Alarm Silence Key.
### Inspiratory/Base/Sigh or CNEP Pressure Out of Range or Constant Pressure Alarm

<table>
<thead>
<tr>
<th>Alarm Bar is flashing</th>
<th>Alarm is sounding.</th>
<th>Will relay message: notifying user which “pressure” is out of range.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leak is large enough that NEV-100 cannot compensate.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1. Hose disconnected</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. PortaLung chamber:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- door improperly sealed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- cracks in plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- collar loose</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3. Combination of settings and PortaLung exceed capabilities of NEV-100</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Check Child</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Chamber and wake child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPap)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact parents</td>
<td></td>
<td></td>
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<tr>
<td>Check hose connections</td>
<td></td>
<td></td>
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<tr>
<td>Reset door or replace seals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair or replace plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjust collar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press Alarm Silence Key</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact parents - settings may need to be readjusted.</td>
<td></td>
<td></td>
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</table>

### High Internal Temperature

<table>
<thead>
<tr>
<th>Alarm bar is flashing</th>
<th>Alarm is sounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message relayed on screen</td>
<td></td>
</tr>
<tr>
<td><strong>1. Air intake vents blocked</strong></td>
<td></td>
</tr>
<tr>
<td><strong>2. Ambient (room) temperature too high.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Check Child</strong></td>
<td></td>
</tr>
<tr>
<td>Open Chamber and wake child up</td>
<td></td>
</tr>
<tr>
<td>Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPAP)</td>
<td></td>
</tr>
<tr>
<td>Contact parents</td>
<td></td>
</tr>
<tr>
<td>Clean air intake vents</td>
<td></td>
</tr>
<tr>
<td>(Keep air intake vents at least 6” from curtains and bedspreads).</td>
<td></td>
</tr>
<tr>
<td>Be prepared to provide manual ventilation “bagging” child or provide alternative ventilation (i.e. BiPAP)</td>
<td></td>
</tr>
<tr>
<td>Turn NEV-100 off and allow unit to cool to temperature less than 40°C</td>
<td></td>
</tr>
<tr>
<td>If condition persists - call RCH Clinical technologists.</td>
<td></td>
</tr>
</tbody>
</table>

### Low Internal Temperature

| Alarm bar is |
| Ambient (room) temperature |
| **Check Child** |
| Open Chamber and wake child up |
| **flashing Alarm is sounding** | **too low.** | **Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPAP)**  
**Contact parents**  
**Turn NEV-100 off and allow unit to warm up to greater than 5°C**  
**If condition persists-call RCH Clinical technologists.** |
|-----------------------------|-----------------|---------------------------------------------------------------------------------------------------|
| **Message relayed on screen** | **Excessive Negative Pressure Alarm or Excessive Base Pressure Alarm** | **Condition has changed from an “Open” system to a tightly sealed system.**  
**Check Child**  
**Open Chamber and wake child up**  
**Commence “bagging” child if unable to wake up or provide alternative ventilation (i.e. BiPAP)**  
**Contact parents**  
**NEV-100 will adjust quickly and deactivate the alarm.**  
**To speed up adjustments, put STANDBY “ON”, wait a minute and then switch to STANDBY “OFF”**.  
**If alarm persists, contact RCH Clinical technologists for possible repair.** |
6 Start of shift equipment checks

6.1.1 PortaLung
1. Make sure the NEV-100 is plugged into the mains power and there is power available.
2. Make sure all the hoses to the chamber are connected
3. Make sure the seals on the door to the chamber and the port holes are not cracked
4. Check that the settings and alarm limits on the NEV-100 are correct
5. Check that the collar can be easily tightened and loosened
6. Check that all the stoppers for the monitor probes are intact.

6.1.2 Oxygen Saturations monitor
1. Monitor plugged into mains power
2. When was measuring probe position last changed (needs to change position every four hours)?
3. Is the monitor showing the heart rate and oxygen saturation?
4. Are the alarm limits set according to the child specific care page?
5. Check to see that the probes are through the holes provided in the chamber and plugs are well sealed around monitor lines.

6.1.3 Oxygen
If oxygen is required check if there is enough oxygen equipment (O2 cylinders, concentrators, tubing) for your shift and the next shift

6.1.4 Resuscitation bag
Make sure the resuscitation bag is available and working

6.1.5 Alternative Ventilation (i.e. BiPAP)
Make sure the alternative method of ventilation is intact, and in working order.

If any of the equipment used for ventilating the child is not working, or needs servicing or repairs, please inform the parents. The parents will need to arrange to return the equipment to the RCH Clinical technologists.
7 Standard checks of a ventilated child

At the beginning of the shift the carer should get a handover from the family or carer in attendance. Together you should check:

- Is the child breathing normally (for them)?
  - Is the breathing faster or slower than normal?
  - Are they working harder to breathe than normal?
  - Is the breathing softer or shallower than normal
  - Can you hear normal breath sounds?
- Do the settings on the ventilator match the ventilation order for the child?
- Is the ventilator plugged into mains power?

During the shift the carer needs to complete standard checks of the child every hour (or more if required). Check the child specific care pages for any other checks required.

During the carer’s shift they may be required to record information from the ventilator. The child specific care page will tell you what you need to record and when to record it.

The following next two pages(attachments) are examples of checklists and observation sheets that will accompany the child.

1. PORTALUNG VENTILATION OBSERVATION SHEET
   - This checklist is to be checked hourly during the period of time with child when PortaLung in use.

2. EQUIPMENT CHECKLIST & VENTILATION PARAMETERS
   - This checklist is to be checked at the start of every shift.
## PORTALUNG VENTILATION OBSERVATION SHEET

**Name:** ____________________________

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>02 Sats</th>
<th>Chest Movement</th>
<th>Heart Rate</th>
<th>Physical Assessment / Care</th>
<th>Bag care</th>
<th>O2 Pressures</th>
<th>Int.</th>
</tr>
</thead>
<tbody>
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**LEGEND:**
- AL = Alarm Limits
- O2 = Oxygen
- BE = Bag emptied
- BC = Bag checked
- T = Toilet
- Int = Initials
### EQUIPMENT CHECKLIST

After receiving handover from the parents, complete checklist before parents retire to bed

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
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#### PORTALUNG VENTILATOR:

<table>
<thead>
<tr>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THU</th>
<th>FRI</th>
<th>SAT</th>
<th>SUN</th>
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<tbody>
<tr>
<td>Ventilation Orders</td>
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<td>Mode</td>
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<td>Wall AC</td>
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<td>Neg. Pressure Setting {cm / H2O}</td>
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<tr>
<td>Base Pressure Setting {cm / H2O}</td>
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<td>Rate {BPM}</td>
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<td>Inspiratory Time {Sec’s}</td>
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<td>IE Ratio</td>
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<tr>
<td>Low Pressure Alarm Limit {cm / H2O}</td>
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<td>Sigh - Pressure {H2O}</td>
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<td>- Frequency</td>
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<td>Portalung checked for air leaks</td>
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#### OTHER EQUIPMENT:

| Oximeter alarm limits set |     |     |     |     |     |     |
| Oximeter wall AC |     |     |     |     |     |     |
| Torch present and working |     |     |     |     |     |     |
| Resuscitator bag & mask |     |     |     |     |     |     |
| Oxygen cylinder over ½ full |     |     |     |     |     |     |
| Oxygen mask available |     |     |     |     |     |     |

Initials